Illinois Department of Transportation
2300 South Dirksen Parkway / Springfield, Illinois / 62764

BDE PROCEDURE MEMORANDUM

NUMBER: 39-04

SUBJECT: Concrete Barrier

DATE: March 8, 2004

This memorandum adds to the information in Sections 38-5.01 and 38-7 of the BDE Manual. It also revised Sections 38-7.02 and 38-7.05(c).

Background

Effective January 1, 2004, the department revised its design of the double-faced, 32 in (810 mm) concrete barrier to incorporate the change to the F-shape. Concurrently, a Standard was issued for the 42 in (1065 mm) barrier.

While Chapter 38 of the BDE Manual discusses warrants for and application of these two versions of concrete barrier, more guidance for selecting one barrier height versus the other is needed.

The 32 in (810 mm) concrete barrier is accepted at Test Level 4 under NCHRP 350. At this performance level, the largest design vehicle is a single unit truck with a mass of 17,600 lb (8000 kg). Testing shows that while this vehicle is safely redirected, it rolls to the side and rides along the top of the barrier. The 42 in (1065 mm) barrier is accepted under the NCHRP 350 criteria at Test Level 5. At this higher performance level, the largest design vehicle is the 79,200 lb (36,000 kg) tractor-trailer truck. For this barrier, the tractor-trailer units are redirected, but likewise show a tendency to roll and slide along the top of barrier. Neither of these barriers meets NCHRP 350 Test Level 6 for a 79,200 lb (36,000 kg) combination with a tanker trailer.

There are no nationally recognized warrants for selecting the height of concrete barrier. Some States have developed guidelines based on traffic levels, geometrics, and other factors. These offer some insight, but do not appear to be directly applicable in Illinois. The Illinois Department of Transportation has developed practices and experience in the use of the two systems. This memorandum draws on a questionnaire to the Districts and represents a consensus of best practices in Illinois for the use of the 42 in (1065 mm) concrete barrier. This memorandum will reinforce and further these best practices.

Applicability

The following procedures are applicable to projects on the State highway system where concrete barrier is warranted in the median or on the roadside.

Procedures – Revised Sections

38-7.02 Types

The *Illinois Highway Standards* present the details on the median barrier types used by the Department. The following briefly describes each type:

1. Steel Plate Beam Guardrail, Type D. The Type D, double steel plate beam guardrail median barrier with strong posts, is a semi-rigid system. Its performance is similar to the steel plate beam guardrail system. This median barrier is most applicable to medians with intermediate width and/or moderate traffic volumes. Another application of the Type D median barrier is for the separation of adjacent on/off ramps at interchanges.

2. Concrete Barrier. The concrete barrier is a rigid system with the F shape face configuration. It will rarely deflect upon impact. While a double faced barrier is normally used, a single faced concrete barrier may be necessary where crossover crashes have been an issue on wider medians or where the median barrier must divide to go around a fixed object in the median (e.g., bridge piers). In this situation, the obstacle is typically encased within concrete to create a level surface from barrier face to barrier face.

The 32 in (815 mm) tall concrete barrier, a NCHRP 350 Test Level 4 design, may not successfully redirect heavy vehicles if the impact speed and angle are high. Therefore, on some highways it may be warranted to install the 42 in (1065 mm) tall concrete barrier. Concrete barriers 42 in (1065 mm) tall are considered NCHRP 350 Test Level 5 designs. However, these taller walls restrict sight distance around horizontal curves and restrict vision for authorized personnel (e.g., police) who wish to view the opposing lanes.

38-7.05(c) Types

The following describes those glare screens used by the Department:

1. Concrete Glare Screen. When glare screen is warranted for a section of roadway with concrete barrier, the designer may specify a concrete glare screen. See *the Illinois Highway Standards* for details. This type of glare screen is advantageous on high volume routes due to its low maintenance.

2. Glare Screen Blades. As an alternative to the concrete glare screen, a series of thin vertical blades may be mounted on top of the concrete barrier. The designer must specify the spacing, height, and longitudinal

spacing of the blades on the plans. See the *Illinois Highway Standards* for details.

3. Chain Link Fence. If a median barrier is not warranted but a glare screen is warranted, the designer should install a chain link fence glare screen using a fabric woven with a maximum 1 in (25 mm) opening between parallel wires. In addition to alleviating glare, the fence will control access across the median. This type of glare screen is also effective in controlling glare between the mainline and adjacent frontage roads because an access control fence is usually required.

Procedures – Added Information

1. Preliminary Engineering

   During Phase I of a project, as stated in Section 11-2.04(g), the designer should identify whether or not a median or roadside barrier is warranted. The selection of barrier type and height should be made as part of the Phase I engineering report for the project. This decision is especially important for early and correct coordination with bridge cross section details.

2. Design Considerations

   A. Height

      Generally, where a concrete barrier is selected, the 42 in (1065 mm) barrier may be used when one or more of the following "contributing factor" dot points is met. Such factors should be documented in the Phase I report to support the decision for the taller barrier height.

      1. Contributing factors for use of 42 in (1065 mm) concrete barrier:

         - High speed freeways with high truck volumes. A high speed facility, defined as 55 mph (90 km/h) or higher posted or design speed. High truck volume is defined as 5000 or more multiple-unit (MU) trucks in the total ADT for the facility.

         - History of median crossover crashes involving large trucks.

         - Appurtenances on concrete barrier. When lighting or other appurtenances will be installed atop concrete barrier, the 42 in (1065 mm) barrier may be preferable to the 32 in (810 mm) barrier. This is because the taller barrier will reduce, but not eliminate the occurrence of errant trucks sliding along the top of the barrier.

- Sharp curves, defined as those for which do not meet current criteria for the facility's design speed. Higher encroachment rates are expected on sharp curves, and such alignments aggravate headlight glare.

- Consistency with established practice or adjacent sections. Provide corridor continuity of barrier design for similar conditions.

- Special cases, such as keeping errant vehicles out of mass transit facilities located in a median, or other critical areas where errant vehicles could create catastrophic consequences.

2. Locations where 42 in (1065 mm) barrier should not be used:

   - The 42 in (1065 mm) concrete barrier should not be used on non-freeways. It would reduce or eliminate sight distance for turning movements.

   - The 42 in (1065 mm) concrete barrier should not be used to separate traffic lanes moving in the same direction (e.g., merging ramps). This would reduce visibility of adjacent traffic in areas of merging or divergence. Other cases may be identified on a case-by-case basis.

B. Placement at Locations other than Medians

1. In some cases, on the outside shoulder of a roadway, guardrail may not be a sufficient roadside barrier. Uses for concrete barrier on roadsides could include:

   a. Need to reduce headlight glare into nearby buildings, or other sensitive areas.

   b. Need to mitigate against headlight glare between frontage roads and the mainline, especially where alignments direct the headlights directly at opposing traffic.

   c. Need to reduce the potential for errant vehicles entering critical areas just beyond the shoulder, especially in high volume urban areas with:

      - Elevated structures over occupied areas. (This applies principally to the structure itself.)

      - Sharply curved roadways.

      - Accident history or potential shows increased risk.

d. Need to minimize repairs and maintenance. In high traffic locations it may be unacceptable to have damaged sections of barrier, and to impose repair operations on the traffic flow. Concrete barrier will often remain undamaged after an impact, while guardrail will require more frequent maintenance and repairs.

The cost increment from guardrail to concrete barrier is more significant than that from 32 in (810 mm) to 42 in (1065 mm) concrete barrier. For roadside barriers, cost comparisons and evaluations of the relative merits of the systems should be made before any decision to use concrete barrier on the outside of the roadway.

C. Consistency of Design

Where the 42 in (1065 mm) concrete barrier is selected, it should be applied consistently throughout the section and/or corridor. Barrier height should not be designed on a site by site basis, but rather, limits of 42 in (1065 mm) barrier should be set to bracket all required locations, and applied throughout. Only when the 32 in (810 mm) barrier can be used on a continuous basis should the height revert to this lower level.

The use of a 42 in (1065 mm) concrete barrier in the median does not imply the appropriate treatment for a roadside barrier along outside shoulders. Generally, steel plate beam guardrail, a Test Level 3 system, will be the barrier of choice for outside shoulders on roadway, and will be coordinated with the use of conventional 34 in (860 mm) bridge parapets. The decision to use concrete barrier at 32 in (810 mm) height or 42 in (1065 mm) height on outside shoulders will be a job-specific design element.

D. Coordination with Glare Screen

The procedures of Chapter 38-7.05(d) cover design of glare screen. However, calculation of detailed height requirements does not imply that the height of glare screen should vary repeatedly from location to location along a job. As with the design of concrete barrier, select the height to bracket the needs of the section, or logical segments. In addition, the height to the top of glare screen should be made using Standard devices, and in the following discrete steps.

If the 32 in (810 mm) barrier is being used, and glare screens are needed, the most likely application will be to add a glare screen to the 32 in (810 mm) barrier.

However, consideration may be given to using the 42 in (1065 mm) barrier alone or with a glare screen. While the 42 in (1065 mm)

barrier may not be necessary for truck volumes, it will both increase truck crashworthyness and raise the effective height of the glare screen. This is most likely to happen either if truck volumes are negligible such that the 42 in (1065 mm) height will suffice, or when a height of more than 51 in (1295 mm) is required.

For locations where the 42 in (1065 mm) barrier is to be used, the concrete glare screen may be added to reach a height of 61 in (1550 mm).

If heights greater than 61 in (1550 mm) are required, then glare screen blades, or special designs using concrete may be considered. The addition of taller concrete barrier or concrete glare screen raises issues regarding control of debris scatter from a collision, as well as the necessary shape and slopes for the taller sections. Contact BDE to coordinate any designs using concrete glare screens above a height of 61 in.

E. Special Issues

The use of concrete barrier often is coincident with restricted right of way and other competing needs for space. Concrete barriers consume available width of right of way. This can complicate the design. This should be recognized early in the project development so budgets can reflect special details, and time for detailed design can be allotted. Where right of way is restrictive, shoulder widths may be affected, and accommodation on existing bridges may be a problem. Special designs, such as vertical concrete barrier, may be possible. Contact the Bureau of Design and Environment for information on this or other special designs.

Where a concrete barrier is added in an existing median, especially when adding lanes, there may be a vertical offset to the profile in superelevated sections. This will create a need for an asymmetrical barrier cross section, and will require a detailed design of the barrier in conjunction with the Standard. It may preclude slipform construction.

Concrete barrier often serves as the base for light poles. The design should consider and provide locations for conduit and other necessary hardware (possibly within or under the barrier). These details need to be coordinated with the Lighting Unit in the Bureau of Design and Environment.

Retrofitting of concrete barrier in an existing unpaved median will necessitate revisions to the drainage plan. The concrete barrier should not be placed at the high point of the cross section, as snow melt and other runoff will cross the traffic lanes. As much as possible, drainage near the median should be toward the barrier, with provision

of inlets and subsurface drainage. Avoid placing the flowline coincident with longitudinal joints.

Median barriers need to allow for emergency access. There are various options, such as overlapping flared ends to create an opening without exposing an end to oncoming traffic, leaving gaps shielded by impact attenuators, or providing movable gating sections.

Flaring the ends to create an opening requires a widened median section, and/or encroachment on the shoulder. Also, the movement for a vehicle to use this opening is more complex than for other options. This option may require alignment offsets for the through lanes.

When using impact attenuators or movable gates with the 42 in (1065 mm) barrier, the barrier should be transitioned to match the device attachment. The movable gates currently available are a unique, proprietary system. Use of proprietary products is generally prohibited, and exceptions are addressed in Chapter 66-1.04(b)(2) of the BDE Manual.

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